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ENHANCE THE FIELD RETTING OF FLAX STRAW WITH MODIFIED LOW COST FARM MACHINERY

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Prepared by: Biolin Research Inc.

Enhance the Field Retting of Flax Straw with Modified Low Cost Farm Equipment

Final Report from

Biolin Research Inc.

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Project Title: Enhance the Field Retting of Flax Straw with Modified Low Cost Farm Equipment

Abstract

The objectives of this study were to develop a lower cost, more effective method to put long intact flax straw in a thin layer to ensure faster, consistent retting and as a result, to increase the profits flowing to flax farmers. After repeatedly trying a number of methods, this study found that a Rowse double bar (sickle) mower offered savings of over $4/acre over the next best alternative and still produced long intact pieces of straw that were consistently retted.

Summary

The objectives of this study were to develop a lower cost, more effective method to put long intact flax straw on the ground in a thin layer to ensure faster, consistent retting of the flax straw and, as a result, to increase the profits flowing to flax farmers. This project initially carried out a series of trials with land rollers, wheeled vehicles and tractors as well as with weighted sleds. The disappointing results led to trying a series of rotary and sickle mowers to see if modifying such cutting devices could meet the goals of this project. Initial results with a modified 15 foot Schulte prototype, model X-315, rotary mower gave acceptable results in average stands of oilseed flax but this mower was a prototype and further modifications were not possible after it was taken to Texas for safety testing. Trials with a commonly used 15-foot Schulte model S-150 were only moderately satisfactory even after some additional modifications to shields and baffles were carried out. The most successful trials were carried out with an 18-foot Rowse double bar (sickle) mower set to cut as low as possible. Although the Rowse mower is not now commonly used in Saskatchewan, it is made in the USA, it can be used for haying operations, it is cheaper than a Schulte mower, it is easier to transport, and it takes less power to operate than a Schulte mower of roughly the same size. Partial budgets (see Table 3 of Appendix I) that compare the operation of land rollers, Schulte rotary mowers and Rowse sickle mowers show that the only option ($3.37/acre) that is cheaper than the Rowse mower ($3.90/acre) is a single pass with a land roller. However, a single pass with a land roller is often not enough to knock all the flax straw down. Often two or more passes with a roller are required and even then the straw is not guaranteed to be knocked down. This would boost rolling costs to more than twice that of a Rowse mower. Hence, this study has shown that a Rowse mower is a lower cost, more effective method to put long intact flax straw on the ground in a thin layer. The only other method that might give as good a quality of straw is a single or double or triple rolling. Since most fields would have to be rolled on average 2.5 times, the Rowse mower offers savings of about $4.52/acre relative to the next best alternative. In an average flax field of 150 acres, this would represent a saving of $678 per field, if a farmer used it to prepare his field for consistent straw retting.

Introduction

Background

The world market for natural fibers (not including wood) is about 25 million tonnes (Mt) annually and is growing about 3% per year or about 750,000 tonnes per year. About 80% of this volume is made up

of cotton fibers and about 2% is made up of flax fiber. Textile quality flax fibers are used to both substitute and compliment cotton and other fibers in textile applications. The world market for man-made fibers is about 40 Mt and includes over 2 Mt of glass fibers. Medium and low quality flax fibers are increasingly being used to substitute for glass fibers in applications like plastic composite auto parts and building wall insulation because flax fibers, compared to glass fibers, are about half the density, are easier to work with, are less abrasive and are easier to recycle or decompose. The use of flax fiber could be greatly expanded in both industrial and textile applications if the quality could be improved, if the consistency could be improved, if larger suppliers existed, if potential end users had experience with using flax fiber, if price levels were more stable and if more "applications use" R & D were carried out. Given our landlocked location and small local market, Saskatchewan should try and target medium and higher end quality flax fiber markets (none of which was produced in the Prairies in the past). Our R & D to date, shows that it is possible to produce for this market and generate higher than normal (for agriculture) returns on investment but there must be incentitives for higher quality at each level of the value chain for a higher quality fiber to be produced.

Biolin Research is building not only a new company but, also a new industry. This takes time, persistence and a lot of funding over a number of years. When we started, the common belief was that flax straw could not ret in Saskatchewan and hence that Saskatchewan could only, at best, produce lower end flax fiber (C$200 to C$600/tonne). Retting is the partial rotting process necessary to get clean high value fibers out of flax straw in a cost-effective manner. We have shown that large scale commercial retting of traditional oilseed flax straw in Saskatchewan is possible if certain nontraditional agronomic, harvest and straw management practices are carried out. We have also shown that the production of fiber flax grown in Europe and handled to produce high-end "long line" flax fiber is also possible and profitable in Saskatchewan conditions. Hence we have shown that Saskatchewan DOES have the potential to be a major supplier of medium and higher end flax fiber (C$800 to C$5,000/tonne) and shive and that a new billion dollar agricultural fiber based industry could evolve here. We have built and are still adding to a pilot plant in Saskatoon that can transform better quality flax straw into a range of different types of flax fiber and shive. This pilot plant is the only place in Canada that can supply small lots of higher end flax fiber and shive for potential end users to try. We are also working with collaborators to develop a testing and grading system for flax straw, fiber and shive (none exists at present in North America). We also continue to work on ways to make all the operations from seeding to processing to grading more cost-effective (i.e., lower unit costs, increase quality) since such activities are needed to make the profit potential even greater and the activities involved even more attractive. We are very much aware that we must make flax fiber and shive based industries not only competitive with other crops on the Prairies but also competitive with existing and potential foreign suppliers of flax fiber.

In the last couple years we have had several flax fiber trading companies and users tell us that our OILSEED FLAX fiber is good enough for textiles and that it is the best quality oilseed flax fiber they have ever seen (textile quality flax fiber has traditionally ONLY been produced from European type FIBER FLAX varieties). This is fantastic news and indicates we are on the right path to developing the potential of the flax fiber industry here in Saskatchewan.

We want to increase the amount of flax straw that is processed and increase the per tonne value of that straw. Flax straw value can be greatly improved if we can produce long pieces of intact straw with no seed holders by harvesting the standing flax crop with a stripper header or straight header. We have

then rolled the remaining standing straw with a land roller or cut it very close to the ground with a disc bine mower. These procedures put the straw flat on the ground in a thin layer and greatly enhance the speed and evenness of retting. Unfortunately, the existing land rollers (i.e., pea rollers) come in long rigid sections and do not do a good job of flattening down straw in rough or sharply sloping fields or at times when the straw is damp. Disc bine mowers are more effective then rollers but are not common and are relatively expensive to use on an acre basis (i.e., $12/acre). We need a machine that is more flexible and effective than a hand roller but cheaper than a disc bine mower.

It is a little known fact that flax stems do not have fiber from ground level up to one or two inches above the ground. If we can strike or hit the flax stem so that it bends within an inch of the ground it generally breaks off, especially when the straw is ripe or has been desiccated. The higher up the straw is struck or hit, the less likely it will break. Similarly, if the straw is green or wet, it is less likely to break. Hence, the need to develop field flexible machinery that can cheaply and effectively hit the straw just above the ground. When the straw is optimally retted, we would use a "V-rake" or side delivery or tether rake to rake up the straw (to date, we have not had problems with raking dirt with the straw) and then bale it with a small square or round baler (for our purposes, large square bales are too risky if they cannot be put into storage immediately).

Rationale

This project could lead to higher profits for farmers and flax straw processors by reducing the cost of field operations and improving the quality of flax straw. Farmers could have a more effective and/or lower cost alternative for placing flax straw in contact with soil compared to existing alternatives like land rollers or disc bine mowers. Added value opportunities for flax straw processing will be seized as the quality of flax straw improves.

The research from this study will be essential for producing large quantities of renewable and biodegradable flax fiber that can be used to replace non-renewable and non biodegradable fibers like glass fiber. In addition, an expanding flax fiber industry will decrease flax straw burning in Saskatchewan by utilizing more of the flax straw that is already produced. Processing flax fiber is a form of "carbon sequestration" since it reduces the amount of carbon released into the atmosphere because it reduces straw burning and an expanding flax fiber industry will make increasing use of a product that is presently wasted or burnt. Flax fiber based industries are prime examples of the type of value added processing the people of Saskatchewan desire (i.e., using an existing waste product, job creation through processing, increased exports, creating the potential for secondary processing).

Objectives

1) Develop a lower cost, more effective, mechanical method to put long intact flax straw flat on the ground in a thin layer covering the whole field (i.e., no thick rows of straw) to ensure fast, consistent retting of flax straw and hence higher profits for farmers and flax straw processors.

2) Increase the profit flowing to flax farmers and flax straw processors from better, more consistently retted flax straw.

Methods

Initial Planned Approach

Field cultivators are readily available in Canada; they come in large widths and can be easily transported. The field cultivator shanks provide a significant amount of downward pressure and flexibility to follow the contours of the land. Developing an attachment to be mounted on a field cultivator shank to place straw in contact with the soil should improve retting compared to a land roller and should still be much cheaper than a disc bine mower. Flax straw processors, custom operators and/or large flax farmers could then add these attachments to used cultivator frames and use them to quickly and cheaply flatten fields of deseeded standing flax straw to produce large areas of long intact retted flax straw. This, in turn, would allow the profitable production of higher end flax fiber and shive and improve the economic potential for processors and farmers.

Initial Planned Methodology

Project steps:

1) After removing the cultivator shovels, three different cultivator shank attachments would be designed and built to each fit and fill at least four feet of a cultivator frame. These would include, but not be exclusive to wide truck tire size tires mounted on bearings, small wheel barrel size tires mounted on bearings, snowmobile type ski type skids, and/or several crowfoot type packer wheels mounted on bearings inside each shank. Additional options will be explored if they appear promising.

2) The attachments will be tested against a land roller to determine their effectiveness in placing flax straw in contact with the soil.

3) The attachments would be tested in fields where the straw was cut as high as possible and the straw has various degrees of maturity.

4) The occurrence of plugging up and effect of terrain and stones would also be recorded.

5) After using in several fields having varying surface characteristics and various maturities of straw, the straw will be allowed to ret and the prototype attachments will receive an initial evaluation.

6) Straw from each treatment will be collected.

7) In the second year, the attachments will be modified, if need be, and used again in fields having various surface characteristics and straw of various maturities. The straw pushed down by the attachments would again be allowed to ret. Sampling of standing straw and collecting and processing of the retted straw will be carried out in the same manner as the first year trials to generate quality and yield data. A final evaluation would be made of the likely cost effectiveness of each type of attachment if it were made into a full-scale machine.

Changes from Initial Plan

In the initial project submission we proposed that we would alter old cultivator frames to make rollers that would be flexible and adjust to small variations in field topography, so that they would be more effective in knocking down a higher percentage of the straw. However, our experience in the fall of 2007 made us reconsider this potential plan of action. In the fall of 2007 we hired farmers to use large land rollers to roll several flax fields in the Hepburn/Laird and Redvers/Bellegarde areas of the province. In only one or two cases were the results totally successful with all the straw broken off and retted in early spring. In most cases, the straw in some parts of the fields did not break off with rolling. Some areas of straw and some individual plants scattered here and there remained standing over winter and had only started to ret when it was time to rake the field in the spring. This could be because, in some cases, the seed furrows in the field were too deep and the rollers did not get hit the straw at the right spot to break it off. In other cases, the straw may have been too thick or too damp, or too green to break off. In most fields there were unexplained areas where large patches the straw did not break off. Although we looked for patterns, and hence, for clear reasons why some straw did not break off, we often could not find a clear explanation.

We also did some trials with small alternative prototype ways to knock down the straw. In the worst field (i.e., the field in which no straw broke down easily) in addition to trying to roll with the land roller, we tried dragging a weighted sleigh with an ATV; we tried driving with a half ton truck; driving with a three ton truck; and driving with dual wheels on a large tractor over the tall standing stubble of the flax crop that had been stripped with a stripper header. The driving was done at 90 degrees, 45 degrees and 180 degrees relative to the direction of the seed furrows. Only the trial with the tractor dual tires going in the direction of the seeding furrows was able to break off some of the straw. After these preliminary trials we were hesitant to try manufacturing alternative types of flexible rollers. As an alternative to a modified roller system, we began to look again at possible cheap but effective methods that could be used to cut flax straw at ground level and spread it in a thin layer without minimal damage to the straw. We discussed this change of approach with Doug Pchajek of the Agricultural Development Fund (ADF) and were told that changes in methodology were acceptable as long as they objectives of the project did not change.

Revised Plan

After discussing our objectives (i.e., to develop a lower cost more effective mechanical method to put long intact flax straw flax on the ground in a thin layer covering the whole field) with Schulte Industries of Englefeld, we decided to try their prototype X-315. This prototype mower was designed to cut large biomass crops including corn stalks in France. From their previous experience in the Northwest of the USA they felt they could modify this prototype mower to cut flax straw in a manner that would imitate what an old-fashioned sickle mower would do (i.e., cut and drop the flax straw in a thin layer directly behind the sickle bar). In late October of 2007, technicians from Schulte Industries brought out the X-315 to a flax field near Hepburn that had both a stand of normal oilseed flax and a small area of heavily seeded fiber flax. The mower had been modified in several ways; "flat blades" had been installed underneath, the solid shields at the back of the mower which replaced the normal chains had been raised and the back of the mower had been raised slightly (so that the blades did not unnecessarily drag the straw around). In addition, the X-315 had adjustable shields between each

section of the mower; these sectional shields were lowered so that straw could not easily pass or be blown from one section of the mower to another (the mower was 15 feet wide and had three blades, each of which occupied a five foot section). The rotation of the blades was also such that the material from the outer blades was blown outward from the mower, rather than inward (in a standard rotary mower made for cutting grass along roads, the blades rotate so the outer blades throw material toward the center of the mower to minimize the chance of stones flying in the direction of passing vehicles). When operating the mower, the throttle was kept low to minimize the rotational speed of the blades. It was felt that this would also help to reduce the amount of straw that was flung around inside the mower housings. In short, the mower was modified and/or operated in an attempt to only cut the straw at ground level and have it fall flat on the ground in an even layer.

Initially when the mower was used in normal oilseed flax straw that had been left tall and standing after being stripped with a stripper header, the mower left most of the straw on the edges of the cut area and little straw in the middle, however, after several hours of adjustments and trials, the spread pattern was evened out and the operator was able to go about eight miles an hour. In the second trial, the mower was used to cut a heavy crop of fiber flax straw stubble that had been stripped and was about half a meter tall. In this case, even with some further adjustment, and various forward speeds, the mower left some straw in clumps; this was no doubt largely due to the high amount of biomass that we were attempting to cut.

In the spring when we went to rake and bale the straw, the thinner layers of normally seeded oilseed flax had retted reasonably well and there was not much difference in the degree of retting between thicker and thinner areas of straw in the field. This was in contrast to the heavily seeded fiber flax where clumps of thick straw had lain over winter and early spring; these clumps of straw were hardly retted at all, relative to the areas in the field where the straw was more evenly spread. Hence, although the X-315 cut all of the straw and thus was an improvement over rolling, the attractiveness of using the X-315 was reduced as the yield of straw per acre increased due to the increasing number of straw clumps as straw yields increased.

In the spring of 2008, we were again able to get access to the Schulte X-315. We used it to cut two fields near Redvers and a field at Hepburn and a field at Laird that had been rolled the previous fall but had large areas of straw still standing. Although we do not anticipate a common practice of rolling and cutting, we explored this option so that we have a backup plan for situations where farmers might have to roll because they don't have access to a mower, but their rolling is only partially successful. The S-315 with its flat blade and type of shielding did not have a problem with wrapping of straw that had already been rolled and broken down. In the last field that was cut at Redvers, the PTO shaft of the X-315 twisted off within the first hour of cutting in the field. No replacement shaft was readily available and we had to take the mower back to Englefeld to have a replacement PTO shaft installed. The PTO shaft was also a new prototype and the metal may have been weaker than needed; the PTO shaft may have been stressed from the mower being used to cut bush in the winter, and/or, the PTO shaft may have been stressed from running the PTO at a low throttle speed to minimize the flinging of the straw (running the PTO at a low throttle speed is actually more stressful on the PTO shaft than running it at a high speed because the momentum is much less at lower speeds). After the PTO shaft was replaced, parts of two more fields were cut and the staff at Schulte Industries have reported no further problem with the PTO shaft.

All the straw that was cut in the fall of 2007 or the spring of 2008 was raked and baled in the spring of 2008. Some samples of this straw were processed with equipment at the Crop Fibers Canada pilot plant. The results showed that the thin layers of oilseed straw that were cut with the Schulte mower produced relatively evenly retted flax fiber. The lumpy layer of straw that was produced by the Schulte mower in the heavy fiber flax stand produced unevenly retted straw, and hence, unevenly retted fiber with not only a wide variation in the fiber fineness, but also in the color of the fiber and in the ease in which the shive could be removed from the fiber. This is not unsurprising since unevenly retted straw cannot produce evenly retted or consistent flax fiber.

In the summer of 2008, we were contacted by Schulte Industries and told that the X-315 that we had tried in 2007 was a one of a kind prototype and that it would be shipped to Texas for safety trials during the fall of 2008 and hence that it would not be available for us to carry out trials with or to try making further modifications on. In its place they proposed that we try their model S-150. About the same time one of our farmer cooperants gave us the name of a rancher that had a Rowse double bar (sickle) mower, which he thought might also work well for cutting flax straw. When we made contact with the rancher and saw the mower, we realized that it was really two nine-foot traditional sickle mowers that has been mounted in an A-frame so that the total cutting width was 18 feet. This mower takes only 50 to 60 horse power (as opposed to 100 to 140 horse power for the 15 foot Schulte Mower), and is easily pulled behind a pickup truck with no need for a transport trailer (i.e., even the 15 foot Schulte mower needs a transport trailer if its transported long distances). In addition the 18 foot Rowse mower costs $12,000 to $16,000 while a Schulte 15-foot mower costs $18,000 to 22,000.

In the fall of 2008, we used both the Schulte mower and the Rowse mower to do a series of side by side comparison cutting trails in the same fields that had been stripped with a stripper header. The S-150 is constructed somewhat differently than the X-315; it has chains instead of solid shields at the back of the cutting units to prevent stones from flying into passing cars. The motion of the outer blades is also such that it throws material towards the center of the machine to minimize the change of stones being flung outward towards cars (i.e., the S-150 is commonly used for cutting grass along the highways). In our initial trials using the S-150, we took the chains off the back of the mower and raised the back of the mower slightly, so that straw, after being cut, could fall directly on the ground without being flung very far, or dragged in lumps by the chains. The Schulte technicians had also installed flat blades under the mower housing instead of the customary "lifting" blades to minimize the amount of cut straw that would be lifted up and cut again. Unfortunately, even after these changes, much of the straw from the center housing was passed to the housing on the right side. Little straw was left in the center of the mower and a small row of straw was produced near both edges of the mower with a somewhat bigger row on the right edge of the mower.

After cutting the first field with the Schulte S-150, the mower was taken back to the Schulte factory in Englefeld and several modifications were made to the mower. These included replacing some of the existing shrouding with shrouds bent in different angles, and altering some guards in the hope of moving the straw in a more even pattern. When these modifications were complete, the mower were taken out to do some additional cutting trials, however the results were similar to the first trial; sometimes the straw was spread evenly, with little or no extra straw out on the edges, other times there was little straw in the center of the cut area and considerable straw spread in a thicker layer near the edges of the cut area behind the mower.

In the fall of 2008, we were also able to observe a new Schulte Model FX-742, a 42 foot rotary mower being used in tall winter wheat stubble. This mower needs a 250 horse power tractor to hold up the hitch and to power it. The operator was able to go 6 to 8 miles per hour and hence to do slightly more than 30 acres an hour, however, this mower also left higher amounts of straw on the edges of the cut area behind the mower. It is not known at this time if a better spread pattern could be achieved with the addition, or modification of shielding baffles and/or if a 42 foot mower could be built that would imitate the action of the X-315. The advantage of such a large mower is a fast work rate per hour, but the disadvantage is the need for a very large tractor and the capital cost that is four to fives times as much capital cost as a 15 foot mower, even though it is only roughly three times wider.

In contrast the Rowse mower did not leave undesired little rows, or little piles of straw. The mower was set so it cut very close to the ground, and several shields were installed so that the straw would not jam into drive belts that were low to the ground. Both the Rowse mower and the Schulte mower were operated at 6 to 8 miles per hour, but the Rowse mower needed roughly half of the horsepower of the Schulte mower to cut 18 feet instead of 15 feet. The Rowse mower extends out on the right side of the tractor much like an old fashioned one way disc, and hence, is the most easily used by going around the field rather than up and down the field. Several farmers used the stripper header in a back and forth direction, and one farmer used the stripper header in a "round the field" pattern to see if a cutting pattern with a stripper header made any difference to cutting the straw with the Rowse mower (because of its construction, the Schulte mower can be used either in a up or down pattern in the field, or a round the field pattern). When the straw was dry and the air was relatively dry; it did not seem to matter much which direction the Rowse mower was used. It always cut standing stubble and always cut or slipped over or cut through the straw that had been pressed down by the combine wheels no matter the angle of the mower relative to the angle of the tire tracks. However, when the straw was damp, the air had a high relative humidity and/or there was snow on the ground, the straw in the tire tracks would often bunch up on the sickle bar and not fall off evenly.

Results

Revised Plan

The trials done over two years produced straw with a wide variety of properties. At the one extreme, in the first year, we had unretted straw in several fields that could not be broken off with any kind of sled or roller-like device (except for the dual wheels on a large tractor). At the other extreme, we had long pieces of evenly retted straw. Once we switched to trials with mowers, we were able to always get the straw on the ground, even in rainy weather or in greener patches of straw or in fields that had relatively deep seed furrows. However, the three Schulte mowers all left some straw in little clumps and piles amongst straw lying in a thin layer. The 315 model left the least number of clumps but it still left some clumps even in a very light stand of flax straw. On the other hand, the Rowse mower seldom left any kind of clumps or piles of straw. Even small clumps or piles of straw are undesirable because the straw does not ret inside the clumps or piles. Consequently, the more clumps and piles, the more inconsistent the retting. Table 1 in the Appendix shows one example of this. Both composite straw samples in Table 1 were taken from the same field and our Fried Hot Water Retting Test shows that both samples were retted to the same degree (i.e., a score of 2.3), however, the Coefficient of Variation (c.v.) was

higher for the straw from the Schulte mower. This means that, of the many pieces of straw tested from each field trial, the pieces of straw from the Schulte mower trial exhibited a higher amount of variation in the amount of retting. This is because some of the pieces of straw in the Schulte trial were relatively unretted straw from the little clumps of straw that the Schulte mower produced.

Length of Straw

In addition to clumping of straw, the Schulte mowers also tended to chop the straw into smaller pieces than the Rowse mower. Table 2 and Figures 1 and 2 illustrate this difference. Once again both composite straw samples in Table 2 were taken from the same field so they original height of the straw and harvest treatment were the same. However, the mowing systems were different and hence the distribution of straw lengths was different. Table 2 presents numbers to show this difference and Figures 1 and 2 illustrates these differences. In Figure 1, pieces of straw were measured for length and counted; in Figure 2, pieces of straw were measured for length and weighed. In both of these figures, we see that the Rowse mower produced a much higher percentage of longer straw pieces. When extracting fiber from straw, the longer the straw, the longer the fiber and the easier and faster the extraction process. Longer fiber is usually more valuable then shorter fibers and faster processing usually means lower per tonne processing costs. Hence, the Rowse mower produces more valuable straw, not only because it is retted more consistently but also because the pieces of straw tend to be longer.

Cost of Flattening Straw

In addition to differences in the quality of straw, there are also differences in the costs of different rolling and mowing options. Partial budgets (see Table 3 of Appendix I) that compare the operation of land rollers, Schulte rotary mowers and Rowse sickle mowers show that the only option ($3.37/acre) that is cheaper than the Rowse mower ($3.90/acre) is a single pass with a land roller. However, a single pass with a land roller is often not enough to knock all the flax straw down. Often two or more passes with a roller are required and even then the straw is not guaranteed to be knocked down. This would boost rolling costs to more than twice that of a Rowse mower. Hence, this study has shown that a Rowse mower is a lower cost, more effective method to put long intact flax straw on the ground in a thin layer. The only other method that might give as good a quality of straw is single or double or triple rolling. Since most fields would have to be rolled on average 2.5 times, the Rowse mower offers savings of about $4.52/acre relative to the next best alternative. In an average flax field of 150 acres, this would represent a saving of $678 per field, if a farmer used it to prepare his field for consistent straw retting.

Conclusions and Recommendations

The Schulte X-315 does a much better job of spreading than the Schulte S-150, however, both mowers need about twice the power of the Rowse mower and, unlike the Rowse mower, need a transport trailer to haul them around. They can be used for cutting hay, straw and grass along the roads when not being used to cut flax straw. The Rowse mower can also be used to cut hay and straw when not being used to

cut flax straw, but it is doubtful that it would be used to cut grass along roadsides unless the ditches were very wide and had little slope.

The Rowse mower can cut just as low as the Schulte mower, appears to spread the straw much more evenly, has a lower capital cost and needs a smaller tractor to operate it.

In stony land the Schulte mower would have less breakdowns than the Rowse mower, but it would not be a recommended practice to collect flax straw from stony fields because of the chance of getting stones into baled straw that is going to a processing line.

In the long term, one can easily imagine a 42 foot X-315, but it is hard to imagine a 42 foot Rowse mower, however, it may be possible to design a "flex header" type sickle mower that would be 30 to 40 feet wide, since 30 to 40 foot wide flex headers that can cut pulse crops already exist.

Obviously, in the long run, faster work rates would make it physically more possible and financially more attractive to carry out post harvest treatments to make flax straw more attractive as a source of high-end fiber and shive.

Based on our experience during this reporting period, we have prepared hypothetical budgets (see Table 1 in Appendix I) for getting long intact straw flat on the ground by using the five most promising scenarios. In the case of the land roller, we have shown two possible costs; one shows the cost if only one pass of the roller is needed (generally more are needed but this represents the lowest possible rolling cost) and the other shows the cost if two or more passes in different directions are needed (this is typical; for costing purposes we assumed an average of 2.5 passes). In the case of the Schulte mowers, both the X-315 and the S-150 are 15 feet wide and cost roughly the same. However, the X-315 does a better job of leaving the straw in an even layer. The Rowse mower has the second lowest cost per acre (only the one-pass roller would be cheaper) and appears to be the most effective. It is just as fast as the 15 foot Schulte mowers and almost as fast as using a land roller doing two passes. It would not be as fast as a 42 foot Schulte mower but it produces a more even result then such a 42 foot mower and potentially will work better in heavier straw yields and be much easier to transport and power.

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NOTE: all of the above and many related references can be found by using Google.

Other

Extension Meetings: none held on this specific topic but results will be included as part of extension meetings in the future

Papers Produced: none to date

Conference Presentations Made: none to date but results will be presented as part of conferences that deal with possible ways to add value to straw

Personnel Involved: Randy Cowan, Dave McDonald, Alvin Ulrich, staff of Schulte Industries, farmer cooperants who are listed in the Appendix

Equipment Purchased: none

Photos: both photos and short videos were taken; several photos are attached; others are available upon request from Biolin Research Inc

Project Materials Developed: no formal materials were developed, however, photos and short videos were taken, straw was produced and sampled, intern and final reports were written, results will be incorporated into future extension presentations

Expense Statement: see accompanying "Information Required for Final Report Funds Disbursement"

Appendix

Table 1 – Level of Retting Test

	Average	c.v.
Straw cut by Shulte Mower	2.3	29.5%
Straw cut by Rowse Mower	2.3	26.9%

Table 2 – Comparison of Lengths of Straw Cut with a Rowse Mower and a Schulte Mower

	Length Testing - # of stems										
Sample Description	0 to 5 cm	5 to 10 cm	10 to 15 cm	15 to 20 cm	20 to 25 cm	25 to 30 cm	30 to 35 cm	35 to 40 cm	40 to 45 cm	45 to 50 cm	50 to 55 cm
Rouse Mower	-	4.0	13.0	12.0	16.0	13.0	58.0	40.0	30.0	14.0	4.0
% of Total	0.0%	2.0%	6.4%	5.9%	7.8%	6.4%	28.4%	19.6%	14.7%	6.9%	2.0%
Schulte Mower - Unretted	22.0	49.0	39.0	28.0	14.0	9.0	2.0	2.0	-	-	-
% of Total	13.3%	29.7%	23.6%	17.0%	8.5%	5.5%	1.2%	1.2%	0.0%	0.0%	0.0%
Schulte Mower - Retted	-	47.0	53.0	37.0	12.0	8.0	7.0	1.0	-	-	-
% of Total	0.0%	28.5%	32.1%	22.4%	7.3%	4.8%	4.2%	0.6%	0.0%	0.0%	0.0%
Schulte Mower - Combined	22.0	96.0	92.0	65.0	26.0	17.0	9.0	3.0	-	-	-
% of Total	6.7%	29.1%	27.9%	19.7%	7.9%	5.2%	2.7%	0.9%	0.0%	0.0%	0.0%

	Length Testing - Weight (g)										
Sample Description	0 to 5 cm	5 to 10 cm	10 to 15 cm	15 to 20 cm	20 to 25 cm	25 to 30 cm	30 to 35 cm	35 to 40 cm	40 to 45 cm	45 to 50 cm	50 to 55 cm
Rouse Mower	-	0.3	1.8	2.4	3.4	2.5	4.4	12.5	10.8	6.2	2.4
% of Total	0.0%	0.6%	3.9%	5.1%	7.3%	5.4%	9.4%	26.8%	23.1%	13.3%	5.1%
Schulte Mower - Unretted	0.6	2.1	3.3	2.1	1.0	1.0	0.1	0.1	-	-	-
% of Total	5.8%	20.4%	32.0%	20.4%	9.7%	9.7%	1.0%	1.0%	0.0%	0.0%	0.0%
Schulte Mower - Retted		3.1	5.2	4.6	0.8	1.3	1.2	0.1	-	-	-
% of Total	0.0%	19.0%	31.9%	28.2%	4.9%	8.0%	7.4%	0.6%	0.0%	0.0%	0.0%
Schulte Mower - Combined	0.6	5.2	8.5	6.7	1.8	2.3	1.3	0.2	-	-	-
% of Total	2.3%	19.5%	32.0%	25.2%	6.8%	8.6%	4.9%	0.8%	0.0%	0.0%	0.0%

Figure 1 – Comparison, by number of stems, of Lengths of Straw cut with a Rowse Mower and a Schulte Mower

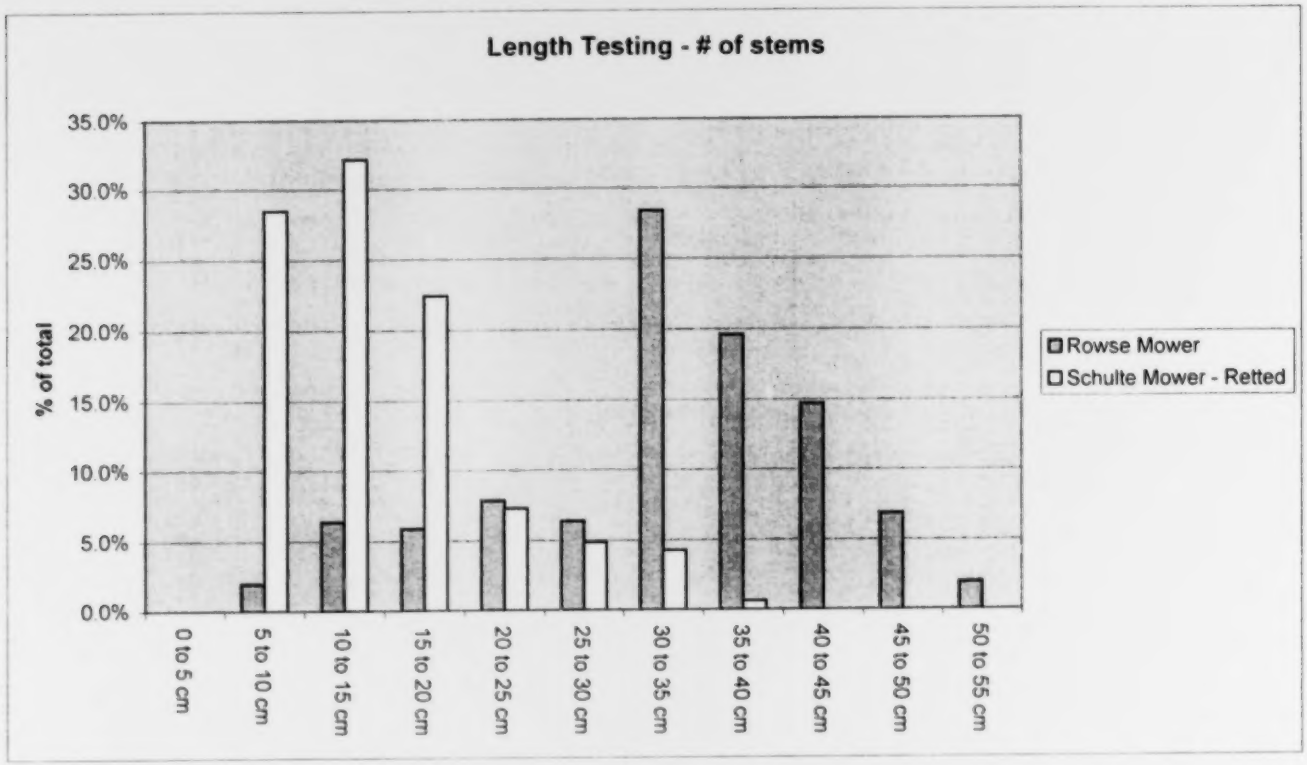

Figure 2 – Comparison, by Weight, of Lengths of Straw Cut with Rowse Mower and Schulte Mower

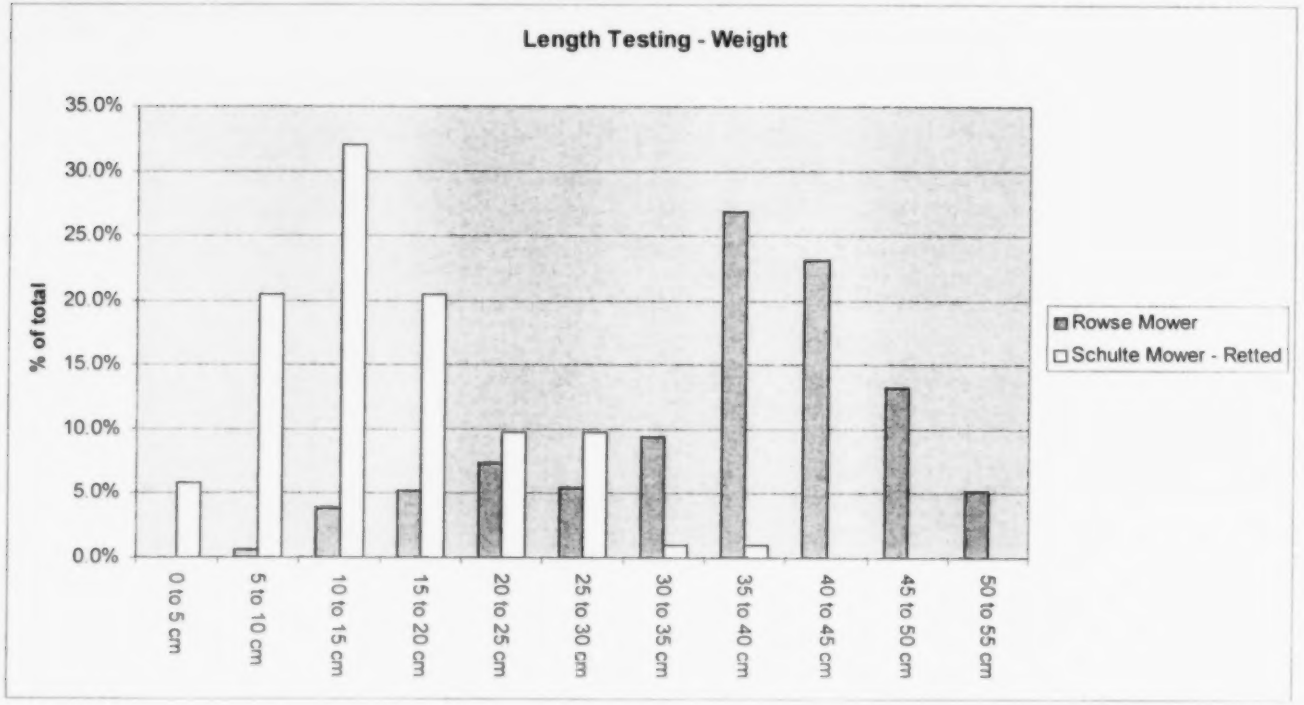

Table 3 - Hypothetical budgets for getting straw on the ground

	Land Roller (40 feet) /a	**Land Roller (40 feet) /a**	**Schulte 15' Rotary Mower /a**	**Schulte 42' Rotary Mower /a**	**Rowse Double Bar Sickle /a**
Minimum Power Unit	Tractor (2WD 120-139 hp) /a	Tractor (2WD 120-139 hp) /a	Tractor (2WD 70-79 hp) /a	Tractor (2WD 250+ hp) /a	Tractor (2WD 60 - 69 hp) /a
Speed of Power Unit (miles/hr)	8	8	8	8	9
number of passes	1	2.5	1	1	1
width of implement (ft)	40	40	15	42	18
Area (acres/hr)	38.8	38.8	14.5	40.7	19.6
Theoretical % efficiency	90%	90%	90%	90%	90%
Time to complete 1 acre(hr)	*0.03*	*0.07*	*0.08*	*0.03*	*0.06*
Cost per acre					
Implement rental	1.32	3.29	3.20	2.22	1.80
Power Unit Rental	1.68	4.20	2.36	3.08	1.36
Labour	0.37	0.93	1.00	0.35	0.74
Total Cost per acre	***3.37***	***8.42***	***6.55***	***5.65***	***3.90***

Assumptions	
Tractor (2WD 50 - 59 hp) /a	18.19 /hr
Tractor (2WD 60 - 69 hp) /a	24.05 /hr
Tractor (2WD 70 - 79 hp) /a	30.81 /hr
Tractor (2WD 100 -119 hp) /a	47.23 /hr
Tractor (2WD 120 -139 hp) /a	58.62 /hr
Tractor (2WD 250+ hp) /a	112.67 /hr
Land Roller (40 feet) /a	45.94 /hr
Rowse Double Bar Sickle /a	31.69 /hr
Schulte 15' Rotary Mower /a	41.70 /hr
Schulte 42' Rotary Mower /a	81.25 /hr
Labour /a	13.00 /hr
one acre	43,560 sq ft
one mile	5,280 linear ft

a/ Source: Saskatchewan Agriculture and Food - Farm Machinery Custom and Rental Rate Guide 2008-09

Table 4 - Summary of Fields and Field Operations

Name	Acres of Flax Seeded, Baled and Rolled	Comments
Leonard Tieszen (07) Hepburn	Acres Mowed with Schulte X-315: 25 Acres Raked: 25 Acres Baled: 25	Field rolled various directions with land roller; straw did not 'break' off and lay down, modified Schulte X-315 mower used to lay the straw down. Straw retted over winter. Straw raked and baled in spring of 2008.
Arnold Klassen (07) Laird	Acres Mowed with Schulte X-315: 125 Acres Raked: 125 Acres Baled: 125	Field rolled various directions with land roller; straw did not 'break' off and lay down, modified Schulte X-315 mower used to lay the straw down. Straw retted over winter. Straw raked and baled in spring of 2008.
Gerry Willems (07) Hepburn	Acres Mowed with Schulte X-315: 70 Acres Raked: 70 Acres Baled: 70	Field rolled various directions with land roller; straw did not 'break' off and lay down, modified Schulte X-315 mower used to lay the straw down. Straw retted over winter. Straw raked and baled in spring of 2008.
Raymond Lamotte (07) Redvers	Acres Mowed with Schulte X-315: 250 Acres Raked: 250 Acres Baled: 250	Field rolled various directions with land roller; straw did not 'break' off and lay down, modified Schulte X-315 mower used to lay the straw down. Straw retted over winter. Straw has been raked and baled in spring of 2008.
Edmond Aime (07) Redvers	Acres Mowed with Schulte X-315: 5 Acres Raked: 0 Acres Baled: 0	Field rolled various directions with land roller; straw did not 'break' off and lay down, modified Schulte X-315 mower used to lay the straw down. Field couldn't be raked or baled due to illness of custom operators. Burnt field.
Bernard Bauche (07) Redvers	Acres rolled with land roller: 0 Acres Raked: 0 Acres Baled: 0	Field rolled various directions with land roller; couldn't get any straw to break off; tried small alternative ways to track down straw but none were very successful. Burnt field.

Leonard Tieszen (08) Hepburn	Acres Mowed with Schulte S-150: 10 Acres Mowed with Double Bar Sickle: 100 Acres Raked: 0 Acres rolled: 140 Acres Baled: 0	Seed harvested with stripper header. Field mowed with Schulte S-150 and double bar sickle. Straw raked and baled in spring.
Ed Ewert (08) Drake	Acres Mowed with Schulte S-150: 20 Acres Mowed with Double Bar Sickle: 50 Acres Raked: 70 Acres Baled: 70	Field mowed with Schulte S-150 and double bar sickle. Straw retted over winter; raked and baled in spring.
Harold Regier (08) Watrous	Acres Mowed with Schulte S-150: 5 Acres Mowed with Double Bar Sickle: 5 Acres Raked: 40 Acres rolled with land roller: 0 Acres Baled: 40 Acres left standing: 40	Partial field mowed with Schulte S-150 and partial field mowed with double sickle mower. Most of field left standing because cutting not done before snow came. All straw was retted by spring when it was raked and baled.
Kelly Pilatus (08) Hepburn	Acres Mowed with Schulte S-150: 0.5 Acres Mowed with Double Bar Sickle: 0.5 Acres Raked: 1.0 Acres Baled: 1.0	Small strip in field was stripped with stripper header and then cut with two different mowers. Field was seeded late and straw was still quite green. Burnt strips when rest of field burnt in spring.

Schulte field man making adjustments to X-315

Schulte mower cutting fiber flax straw; cut oilseed flax stubble in background

Checking Rowse double bar sickle mower

Side view of Rowse double bar sickle mower